United States Department of Agriculture

Soil Conservation Service

Economic Research Service

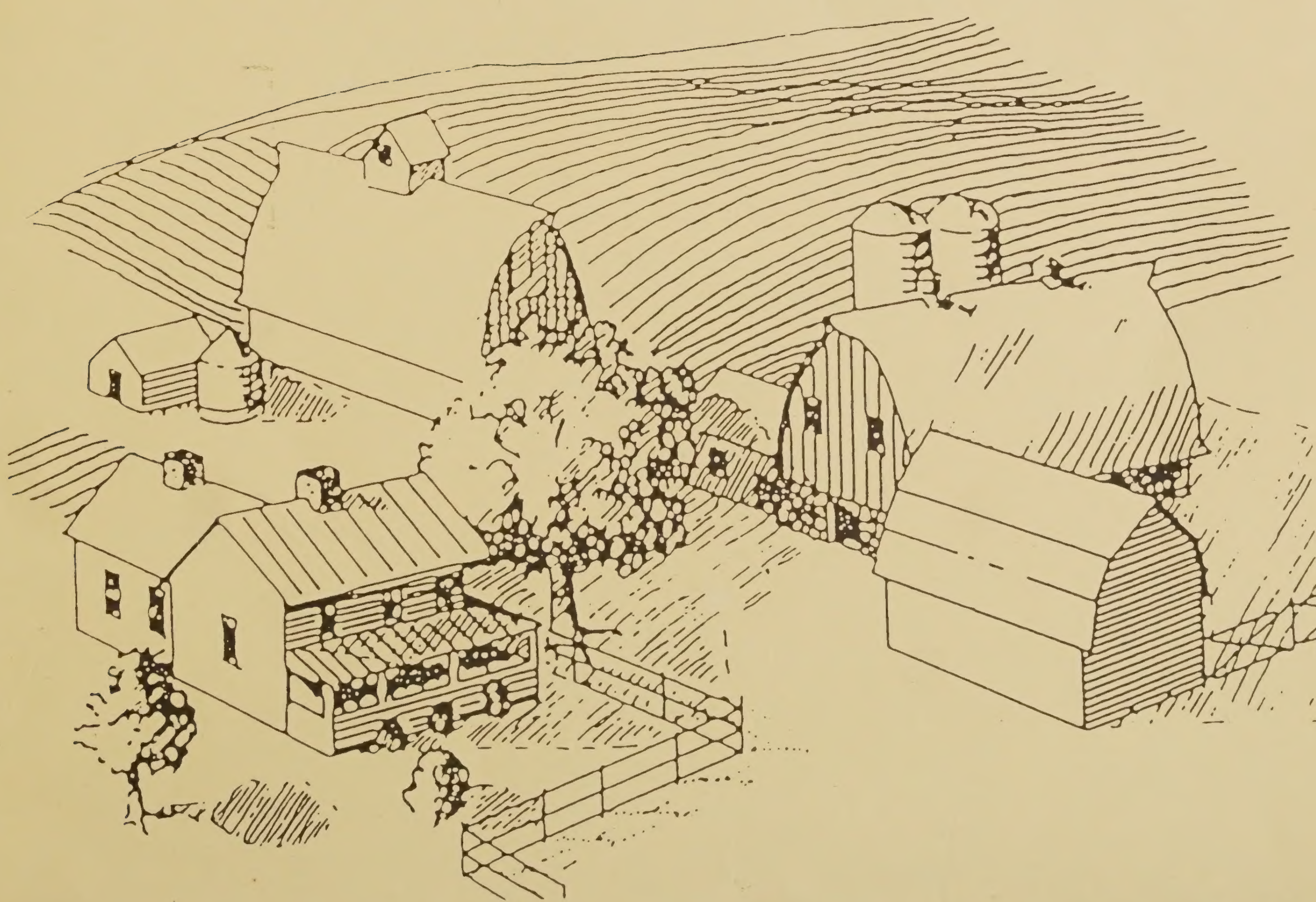
Forest Service

In cooperation with

State of Kentucky

Kentucky Special Resource Study

A Report on Pesticide Use in Kentucky



KENTUCKY SPECIAL RESOURCE STUDY

A REPORT ON PESTICIDE USE IN KENTUCKY

Prepared by

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
Economic Research Service
Forest Service

In Cooperation with

Kentucky Natural Resources
and Environmental Protection Cabinet

1983
PESTICIDE USE

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INTRODUCTION

With today's concerns for clean water, there is increasing pressure to examine pollutants entering our water systems. Consequently, agriculture is being questioned about its contribution to water pollution. The agriculture industry, in general, is classified as a non-point source because its pollutants are dispersed and diffused in nature. Dispersal of agricultural pollutants to the environment are usually by water, sediment, and air. This report does not deal with pollution from irrigation return water, or pesticides transported by wind, but it is concerned with pesticide movement in runoff water and attached to sediment. It does not establish pollution control goals or suggest criteria that should be met by a plan. Its objective is to provide information to those concerned about the extent of water pollution from the use of pesticides primarily by agriculture.

This report summarizes the results of a literature review of the pesticides used in Kentucky and their environmental impacts. The report was conducted by the River Basin Planning Staff of the Soil Conservation Service, Lexington, Kentucky, in cooperation with the Economic Research Service, U.S. Forest Service, and the Kentucky Natural Resources and Environmental Protection Cabinet. Efforts to find data on pesticide use were near futile with the exception of one comprehensive survey conducted by the University of Kentucky Department of Agriculture entitled "Pesticide Use by Kentucky Certified Applicators - 1979." This survey was conducted in 1980 to reflect 1979 pesticide usage. The data on pesticide use by commercial and private applicators were kept separate in the university report, whereas this report combines the two categories into one. Therefore, the tables in this report are a result of combining the two categories into one data set.

INTRODUCTION

With today's concerns for clean water, there is an intense effort by many to identify pollutants entering our water systems. Consequently, agriculture is being questioned about its contribution to water pollution. The agricultural industry, in general, is classified as a nonpoint source because the pollutants are dispersed and diffuse in nature. Dispersion of agricultural pollutants to the environment are usually by water, sediment, and air. This report does not deal with pollution from irrigation return, nor pesticides transported by wind, but it is concerned with pesticide movement by runoff water and attached to sediment. It does not attempt to interpret the results or suggest criteria that should be met by a plan. Its objective is to provide information to those concerned about the extent of water pollution from the use of pesticides primarily by agriculture.

This report summarizes the results of a literature review on the pesticides used in Kentucky and their environmental impacts. The report was prepared by the River Basin Planning Staff of the Soil Conservation Service, Lexington, Kentucky, in cooperation with the Economic Research Service, U.S. Forest Service, and the Kentucky Natural Resources and Environmental Protection Cabinet. Efforts to find data on pesticide use were not fruitful with the exception of one comprehensive survey conducted by the University of Kentucky Department of Agriculture entitled "Pesticide Use by Kentucky Agricultural Applicators - 1979." This survey was conducted in 1980 to reflect 1979 pesticide usage. The data on pesticide use by commercial and private applicators were kept separate in the university report, whereas this report combines the two categories into one. Therefore, the values in this report are a result of combining the two categories into one data set.

PESTICIDE USE

History

The first synthetic, organic insecticides and herbicides were developed and produced in the early 1900's. Chlorinated hydrocarbons came into commercial production in the 1940's, and organic phosphates began to be commercially produced during the 1950's. In the late 1950's, carbamates were developed and included insecticides, herbicides, and fungicides. The 1960's saw a trend toward specific and specialized pesticides and each decade has brought more and varied types of pesticides into existence. This eventually led to the regulation of pesticides by passage of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) in 1972.

National Trends and Projections

Despite the fears and problems created by the use of pesticides, man has elevated his physical well-being and his standard of living through their use. He has been able to do this by producing more food and fiber more efficiently. In the United States, as well as the rest of the world, pest control is essential because crops, livestock, and man live in a competitive environment. Without a doubt, pesticide use will continue to be a part of mans future.

"The use of chemical pesticides in the United States has generally increased up to 15 percent annually over the past decade (Cooperative Extension Service, 1973). It is likely that nationwide pesticide purchases will continue to increase by a similar percentage over the next few years. In particular, Eichers (1981) speculated that insecticide purchases for 1981 were likely to be 10-15 percent over the last two years, while herbicide use was expected to rise 5 percent. This is attributed to the increased use of herbicide mixtures, herbicide tank mixes, post-emergence weed control chemicals, reduced-tillage and no-tillage practices, and more adoption of pest management programs. Development of more effective chemicals, however, is resulting in a decline in the amount of pesticides needed for some crops (Eichers and Serletis, 1982)" (KNREPC-DW, 1983).

Table 1 shows that pesticide use in Kentucky is increasing at a rate greater than the reported 15 percent per year for the nation.

TABLE 1: Pesticide Chemicals Used on Kentucky Farms With Sales of $2,500 or more in 1974 and 1978 1/

Pesticide Use	1978	1974	Percent Increase
Sprays, dusts, granules, fumigants, etc. to control:			
Insects on hay and other crops			
farms	30,679	-----	---
acres	951,333	487,200	95.2
Nematodes in crops			
	3,257	411	692.5
farms	96,772	6,278	1443.9
acres			
Diseases in crops and orchards			
farms	2,032	337	503.0
acres	57,773	11,571	399.3
Weeds, grass, or brush in crops and pasture			
farms	29,184	-----	---
acres	2,086,423	1,039,440	100.7
Chemicals for			
Defoliation or for growth control of crops or thinning of fruit			
farms	8,346	2,168	285.0
acres	102,466	27,713	269.7
Insect control on livestock and poultry			
farms	24,104	4,975	384.5
Sanitation, rodent and bird control			
farms	10,848		

1/ Modified from Table 15, p. 8., 1978 Census of Agriculture, Vol. 1, Part 17.

Source: From the Kentucky Natural Resources and Environmental Cabinet, Division of Water Report on Pesticide, March 1983.

Quantities

Data on the quantities of pesticides used in Kentucky in 1979 were provided by a comprehensive pesticide usage survey conducted by the Cooperative Extension Service of the University of Kentucky College of Agriculture, and from a report developed by Kentucky Natural Resources and Environmental Protection Cabinet, Division of Water (KNREPC-DW, March 1983). As noted by the KNREPC report, "Comprehensive pesticide use data for the Commonwealth of Kentucky is generally lacking....by and large, one report entitled "Pesticide Use by Kentucky Certified Applicator-1979"....is the most comprehensive data to date." The KNREPC report provides additional data from the 1978 census of agriculture and unpublished data from the Kentucky Division of Forestry and the U.S. Forest Service.

The University of Kentucky survey was taken from the state's 898 commercial applicators and 2,000 of the 80,000 registered applicators. Commercial applicators returned 325 completed questionnaires (36.2 percent) and private applicators returned 371 completed questionnaires (18.5 percent).

The 1979 survey results show commercial applicators using approximately 2.1 million pounds of pesticide active ingredients and private applicators using approximately 20 million pounds of active ingredients. The State total was calculated to be approximately 22.1 million pounds (Table 2).

Pesticide use was reported according to the following categories: agricultural, forest, ornamental and turf, rights-of-way, industrial, institutional, structural and health related, and aerial (Table 3). Aerial was altered to "other" for this report, because it indicates a method of application, and because some of the pesticides under this category were used in agriculture, forestry, and rights-of-way.

TABLE 2: Distribution by Use Classification of Pesticide Active Ingredients Applied by Kentucky Certified Commercial and Private Applicators in 1979.

Use Classification	Active Ingredient (pounds)	Percent of State Total
(1) Herbicide	17,965,229	81.2
(2) Insecticides/Acaricides Nematicides	3,001,889	13.6
(3) Fungicides	789,009	3.6
(4) Plant Growth Regulators	260,435	1.2
(5) Fumigants	92,330	0.4
(6) Rodenticides	278	----
Total	22,109,170	100

Source: University of Kentucky Survey entitled "Pesticide Use by Kentucky Certified Applicators - 1979."

TABLE 3: Estimated Total Pounds of Pesticide Active Ingredient Used by Six Categories of Kentucky Certified Commercial and Private Applicators in 1979.

Category	Active Ingredient (pounds)	Percent of State Total
(1) Agricultural	21,011,840	95
(2) Forest	797	----
(3) Ornamental & Turf	189,620	0.90
(4) Right-of-Way	199,066	0.90
(5) Industrial, Institutional, Structural, & Health Related	208,937	0.95
(6) Other 1/	498,910	2.25
Total	22,109,170	100

1/ Seed treatments, livestock pest, rodenticides, stored grain treatment, chemicals applied to gardens and lawns.

Source: University of Kentucky Survey entitled "Pesticide Use by Kentucky Certified Applicators - 1979."

Distribution

Agriculture is by far the major user of pesticides in Kentucky with most chemicals being applied to farm crops. Approximately 21,011,840 pounds of pesticides were used by private and commercial applicators on the farm, with herbicides accounting for 85.5 percent of the quantity. Table 4 gives a breakdown on pesticide use by crops.

TABLE 4: Pesticides Applied to Crops by Kentucky Certified Private Applicators in 1979. 1/

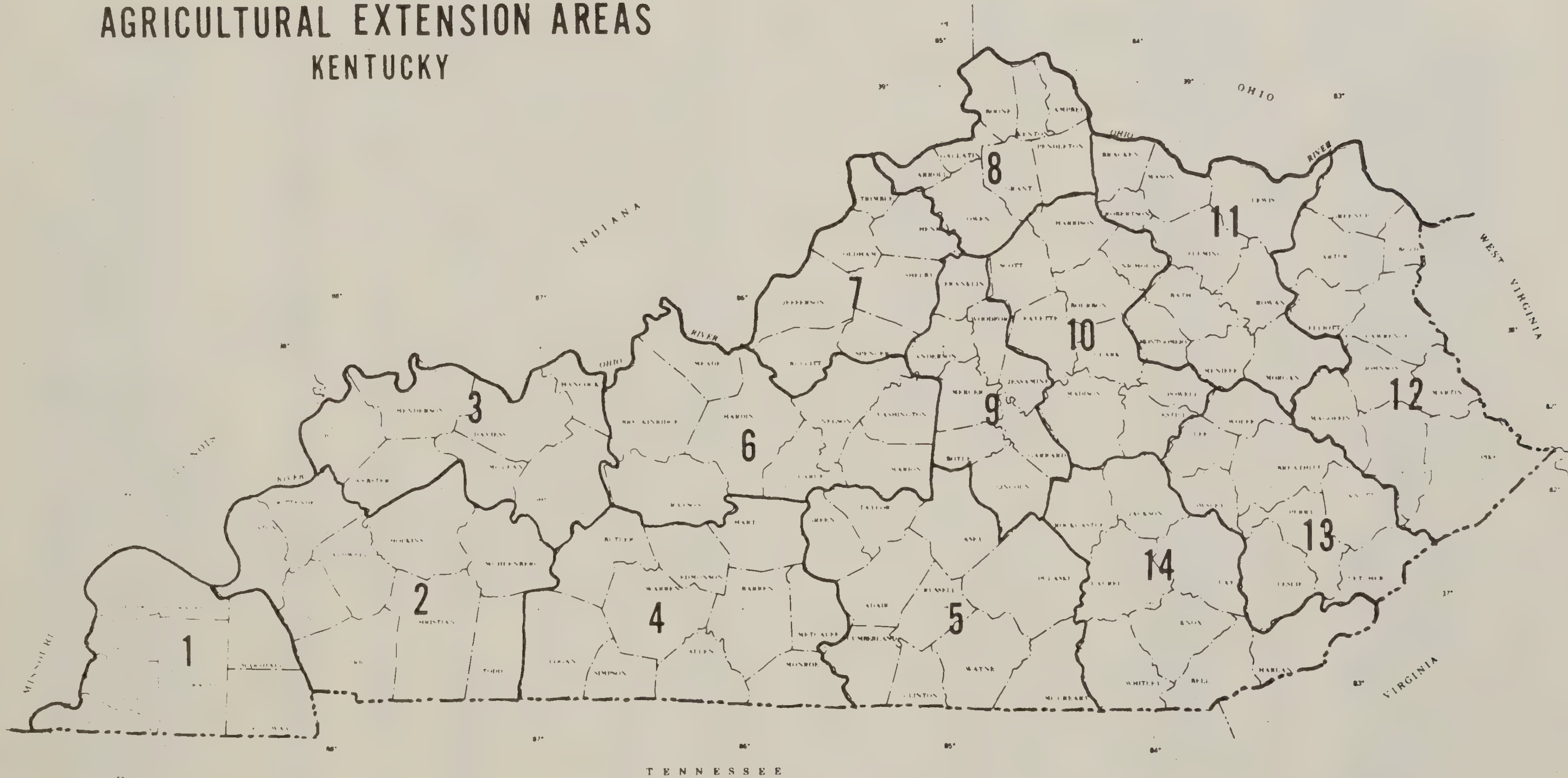
Crop	Quantity Applied Pounds	(% of total)	Herbicide (%)	Insecticide (%)	Fungicide (%)
Corn	8,959,573	(45.4)	89.5	10.3	0.2
Corn (no till)	2,549,836	(12.9)	75.8	23.7	0.5
Soybean	5,815,590	(29.5)	98.6	1.4	0
Tobacco (burley)	1,160,468	(5.9)	67.4	31.6	1.0
Tobacco (dark)	147,286	(0.7)	41.4	56.6	2.0
Commercial Fruits	859,606	(4.4)	0.7	16.5	82.8
Alfalfa	81,863	(0.4)	3.3	96.7	0
Small Grain	69,865	(0.4)	100	0	0
Commercial Vegetables	39,204	(0.2)	49.3	33.7	17
Sorghum	38,212	(0.2)	58.5	41.5	0
Total	19,721,103	100			

1/ 1,290,737 pounds of pesticides applied by commercial applicators are not shown in Table 4.

Source: University of Kentucky Survey entitled "Pesticide Use by Kentucky Certified Applicators - 1979."

Since agriculture is the major user of pesticides, it is not surprising that the more intensive agriculture counties in western Kentucky account for the largest volume of chemicals used. The University of Kentucky survey identified pesticides used by Agricultural Extension Areas, (Table 5), and Figure 1 shows counties in each Agricultural Extension Area.

AGRICULTURAL EXTENSION AREAS
KENTUCKY



Percent of Pesticide Used by Certified Applicators in 1979.

1 - Purchase	14.1	5 - Lake Cumberland	14.0	9 - Fort Harrod	2.9		
2 - Pennyrile	13.6	6 - Lincoln Trail	12.1	10 - Bluegrass	3.3		
3 - Green River	14.2	7 - Louisville	7.1	11 - Licking River	3.6	13 - Quicksand	0.2
4 - Mammoth Cave	11.2	8 - Northern Kentucky	1.1	12 - Northeast Kentucky	1.6	14 - Wilderness Trail	1.0

Figure 1

TABLE 5: Distribution of Pesticides Applied by Kentucky Certified Private and Commercial Applicators in 1979 by Agricultural Extension Area.

Extension Area	Active Ingredient (pounds)	Percent of State Total
1. Purchase	3,129,528	14.1
2. Pennyvile	3,003,848	13.6
3. Green River	3,140,286	14.2
4. Mammouth Cave	2,472,594	11.2
5. Lake Cumberland	3,096,662	14.0
6. Lincoln Trail	2,670,562	12.1
7. Louisville	1,574,259	7.1
8. Northern KY	243,123	1.1
9. Fort Harrod	645,055	2.9
10. Bluegrass	723,510	3.3
11. Licking	788,471	3.6
12. Northeast	366,475	1.6
13. Quicksand	36,978	0.2
14. Wilderness Trail	217,818	1.0

Source: University of Kentucky Survey entitled "Pesticide Use by Kentucky Certified Applicators - 1979."

Types, Transport Modes and Persistence

The classification of major herbicides by common name, trade name, chemical class, transport mode, persistence, and some of the quantities used in Kentucky are shown in Table 6. The same data for instecticides and miticides are shown in Table 7. The fungicides and their classification are shown in Table 8.

TABLE 6: HERBICIDES-Types, Transport Modes, Persistence in Soils and Quantities

Common Name	Trade Name(s)	Chemical Class 1/	Predonminant Transport Mode2/	Approximate Persistence in Soil (days)	Quantities (pounds)3/
Alachlor	Lasso	AM	SW	40-70	2,822,147
Ametryne	Euik	TZ	SW	30-90	-----
Amitrole	Amino, Triazole	TZ	W	15-30	-----
Asulam	Asulox	CB	W	25-40	-----
Atrazine	Aatrex	TZ	SW	300-500	3,891,363
Barban	Carbyne	CB	S	20	-----
Benefin	Balan	NA	S	120-150	-----
Bensulide	Betasan	AM	S	500-700	35,876
Bentazon	Basagran	DZ	W	---	674.322
Bifenox	Modown	AR	S	40-60	266,385
Bromacil	Myuar	DZ	W	700	-----
Bromoxynil	Brominal Buctril	NT	SW	---	-----
Butylate	Sutan	CB	S	40-80	2.424,579
Cacodylic Acid	Siluisar 510	AS	S	---	-----
CDAA	Randox	AM	W	20-40	-----
CDEC	Vegadex	CB	SW	20-40	-----
Chloramben	Amiben	AR	W	40-60	-----
Chlorbromuron	Bromex	UR	SW	---	-----
Chloroxuron	Tenoran	UR	S	300-400	-----
Chlorpropham	CIPC, Furloe	CB	SW	120-260	-----
Cyanazine	Baladex	TZ	SW	---	-----
Cycloate	Ro-neet	CB	SW	120-220	-----
2, 4-D Acid	Many	PO	W	10-30	168,550
2, 4-D Amine	--	PO	W	10-30	-----
2, 4-D Ester	--	PO	S	10-30	-----
Dolapon	Dowpon	AL	W	15-30	-----
2, 4-DB	Butyrac	PO	S	---	56,150
DCPA	Dacthal	AR	S	400	-----
Diallate	Aradex	CB	S	120	-----
Dicamba	Banvel	AR	W	---	-----
Dichlobenil	Casoran	NT	S	60-180	-----
Denitramine	Cobex	NA	S	90-120	-----
Dinoseb	Basanite, Sinox	PH	SW	15-30	-----
Diphenamid	Dymid, Enide	AM	W	90-180	-----
Diquat	Diquat	CT	S	>500	-----
Diuron	Karmex	UR	S	200-500	71,772
DSMA	Many	AS	S	---	-----
Endothall	Endothall	PH	W	---	-----
EPTC	Eradacane, Eptan	CB	SW	30	1,203,534
Fenac	Fenac	AR	SW	350-700	-----
Fenuron	Dybar	UR	W	30-270	-----
Fluchloralin	Basalin	NA	--	---	301,108
Fluometuron	Cotoran	UR	SW	---	-----
Fluorodifen	Soyex, Preforan	AR	S	---	-----
Glyphosate	Roundup	AL	S	150	-----
Isopropalin	Paarlan	NA	S	150	-----

TABLE 6 Continued

Common Name	Trade Name(s)	Chemical Class 1/	Predonminant Transport Mode2/	Approximate Persistence in Soil (days)	Quantities (pounds)3/
Linuron	Lorox	UR	S	120	----
MBR 8251	Destun	AM	SW	---	----
MCPA	Manu	PO	SW	30-180	----
Metribuzin	Sencoe	TZ	W	150-200	489,365
Mecoprop	Mecopex	PO	--	---	34,274
Metolachlor	---	AM	--	---	784,162
Molinate	Ordam	CB	W	80	----
Monuron	Telvar	UR	SW	150-350	----
MSMA	ANSAR	AS	S	---	----
Naptalam	Alanap, NPA	AR	W	20-60	----
Nitralin	Planouin	NA	S	---	----
Nitrofen	TOK	PO	S	---	----
Oryzaline	Pyzelan, Surflan	AM	S	---	----
Paraquat	Gramoxone	CT	S	>500	286,745
Pebulate	Tillam	CB	S	50-60	519,193
Phenmedipham	Prowl	CB	S	100	----
Picloram	Tordon	AR	W	550	----
Profluralin	Tolban	NA	S	320-640	----
Prometone	Promitol	TZ	S	>400	----
Prometryne	Caparol	TZ	S	30-90	----
Promamide	Kerb	AM	S	60-270	----
Propachlor	Ramrod	AM	W	30-50	----
Propanil	Stam F-34	AM	S	1-3	----
Propazine	Milogard	TZ	S	200-400	----
Propham		CB	W	20-60	----
Pyrazon	Pyramid	DZ	W	30-60	----
Pemdemethalin		NA	--	---	225,738
Silvex		PO	SW	---	----
Simazine	Princep	TZ	S	200-400	642,919
2, 4, 5-T	Many	PO	W	---	----
Terbacil	Sinbar	DZ	W	700	----
Vernolate	Vernam	CB	SW	50	----

1/ Chemical type designations: AL, aliphatic acids, AM, amides and anilides; AR, aromatic acids and esters; AS, arsenicals; CB, carbamates and thiocarbamates; CT, cationics; DZ, diazines; NA, nitroanilines; NT, nitriles; PH, phenols and dicarboxylic acids; PO, phenoxy compounds; TZ, Triazines and Triazoles; UR, ureas.

2/ The letter S denotes those chemicals that will most likely move primarily with sediment, W denotes those that will most likely move primarily with water, and SW denotes those that will most likely move in proportion with both sediment and water.

3/ Pounds of major herbicides used by certified Kentucky applicators in 1979.

Source: Agricultural Research Service and Environmental Protection Agency document entitled "Control of Water Pollution from Cropland" Volume I, 1975, and University of Kentucky Survey entitled "Pesticides Used by Kentucky Certified Applicators - 1979."

TABLE 7: Agricultural Insecticides and Miticides-Types, Transport Modes, and Quantities

Common Name	Trade Name	Chemical Class 1/	Predonminant Transport Mode 1/	Quantities 2/ (pounds)
Aldicarb	Temik	CB	W	----
Aldrin	Aldrite, Others	OCL	S	----
Allethrin	Pynamin	PY	S	----
Acephate	Orthene	OP	S	107,160
Aspon	---	OP	S	36,328
Azinphos ethyl	Ethyl Guthion	OP	S	----
Azinphos methyl	Guthion	OP	S	----
Benzene hexachloride	Benzahex	OCL	S	----
Binapacryl	Morocide	N	U	----
Bufencarb	Bux	CB	S	----
Carbaryl	Sevin	CB	SW	104,970
Carbofuran	Furadan	CB	W	1,472,935
Carbophenothion	Trithion	OP	S	----
Chlorbenside	Chlorocide	S	S	----
Chloradane	Many	OCL	S	115,053
Chlordimeform	Fundal	N	W	----
Chlorobenzilate	Acaraben	OCL	S	---- 1
Chlorpyrifos	Dursban	OP	U	99,363
DDT	Many	OCL	S	----
Demeton	Systox	OP	W	----
Diazinon	Spectracide	OP	SW	32,151
Dicofol	Kelthane	OCL	S	----
Dicrotophos	Bidrin	OP	W	----
Dieldrin	Dieldrite	OCL	S	----
Dimethoate	Cygon	OP	W	----
Dioxathion	Delnav	OP	S	----
Disulfoton	Di-Syston	OP	S	----
Endosulfan	Thiodan	OCL	S	68,252
Endrin	---	OCL	S	----
EPN	---	OP	S	----
Ethion	---	OP	S	----
Ethoprop	Mocap	OP	U	----
Fensulfothion	Dasanit	OP	SW	----
Fonsfos	Dyfonate	OP	S	----
Heptachlor	Drinox-H34	OCL	S	19,949
Landrin	---	CB	SW	----
Lindane	Lintox	OCL	S	
Malathion	Cynthion	OP	WS	157,015
Metaldehyde	---	O	W	----
Methidathion	Supracide	OP	U	----
Methomyl	Lannate	CB	U	25,535
Methoxychlor	Marlate	OCL	S	----
Methyl demeton	---	OP	W	----
Methyl parathion	Many	OP	SW	----
Mevinphos	Phosdrin	OP	W	----
Mexacarbate	Zectran	CB	SW	----

TABLE 7 Continued

Common Name	Trade Name	Chemical Class 1/	Predonminant Transport Mode 1/	Quantities 2/ (pounds)
Monocrotophos	Azodrin	OP	W	----
Naled	Dibrom	OP	S	----
Ovex	---	S	S	----
Oxythioquinox	Morestan	S	S	----
Parathion	Many	OP	S	----
Perthane	---	OCL	S	----
Phorate	Thimet	OP	SW	----
Phosalone	Zolone	OP	S	----
Phosmet	Imidan Prolate	OP	S	115,053
Phosphamidon	Dimecron	OP	W	----
Propargite	Omite	S	U	----
Propoxur	Baygon	CB	W	----
TDE	---	OCL	S	----
TEPP	Vapotone	OP	W	----
Tetrachlorvinphos	Gardona	OP	S	----
Tetradifon	Redion V-18	OCL	SW	----
Thionazin	---	OP	W	----
Toxaphene	Strobane T	OCL	S	309,140
Trichlorfon	Dylox	OP	W	57,609
Terbufos		OP	--	57,609

1/ OCL, organochlorine; OP, organophosphorus; CB, carbamates; N, miscellaneous nitrogen compounds; PY, synthectic pyrethrin; S, aromatic and cycle sulfur compounds; O cyclic oxygen compounds. W, denotes those pesticides most likely to move with water; S, denotes those pesticides most likely to move with sediment, and SW, denotes those pesticides most likely to move with both sediment and water. U, denotes those whose predominant mode of transport cannot be predicted because properties are unknown.

2/ Pounds of insecticides and miticides used by certified Kentucky applicators in 1979.

Source: Agricultural Research Service and Environmental Protection Agency document entitled "Control of Water Pollution from Cropland" Volume I, 1975, and University of Kentucky Survey entitled " Pesticides Used by Kentucky Certified Applicators - 1979."

TABLE 8: Agricultural Fungicides-Types, Transport Modes, and Quantities

Common Name	Trade Name	Predominant Transport Mode 1/	Quantities 2/ (pounds)
Anilazine	Dyrene	S	26,314
Benomyl	Benlate	S	29,615
Captafol	Difolatan	S	22,552
Captan	Orthocide	S	----
Carboxin	Vitavax	SW	----
Chloroneb	Demosan	U	----
Cycloheximide	Acti-Dione	W	----
DCNA	Botran	S	----
Dichlone	Phygon	S	----
Dichlozoline	---	S	----
Dinocap	Karathane	U	----
ETMT	---	U	----
Fenaminosulf	Lesan	W	----
Ferbam	Fermate	SW	754
Folpet	Phaltan	S	92,546
Maneb	Dithane M-22 Manzate D	S	----
Metiram	Polyram	S	----
Nabam	Dithane D-14	W	----
Ocycarboxin	Plantvax	W	----
Parinol	Parnon	U	----
PCNB	Terraclor	S	----
SMDC	---	W	----
Thiram	Arasan Tersan	S	----
TPTH	---	U	----
Zineb	Dithane S-78 Parzate	S	----
Ziram	Zerlate	W	----
Mancozeb	Dithane M-45	--	303,329
Sulfur	---	--	257,683
Thiobendazole	---	--	6,723
Copper	---	--	1,697
Methal Isothiocyanate	---	--	1,515

1/ The letter S denotes those pesticides most likely to move with sediment; SW, denotes pesticides most likely to move with sediment and water; W, denotes pesticides most likely to move with water. U, denotes those whose predominant mode of transport cannot be predicted because properties are unknown.

2/ Pounds of fungicides used by certified Kentucky applicators in 1979.

Source: Agricultural Research Service and Environmental Protection Agency Publication entitled "Control of Water Pollution from Cropland" Volume I, 1975, and University of Kentucky Survey entitled "Pesticides Used by Kentucky Certified Applicators - 1979."

Pesticide Use in Silviculture

A variety of pesticides are used in Kentucky's State and National Forests, but the quantities are small when compared to pesticide used in agriculture. Table 3 shows 797 pounds of active ingredients used in Kentucky forests in the year 1979. According to William A. Williams of the Daniel Boone National Forest (Winchester) and the USFS FY-82 pesticide use report (unpublished), approximately 5,478 acres of Daniel Boone National Forest were treated with 12,612 pounds of pesticides (Table 9).

TABLE 9: Pesticide use in the Daniel Boone National Forest, FY-82

Pesticide (type)	Common Name	Purpose	Pounds Used
Herbicide	Ammonium salt of fosamine	Vegetative control along highway	240
Herbicide	Sodium metaborate Sodium chlorate	Vegetative control along highway	2 1
Herbicide	MSMA	Vegetative control along highway	30
Herbicide	Glyphosphate	Vegetative control along highway	35
Herbicide	Amitrol	Vegetative control along highway	176
Herbicide	Simazine	Vegetative control along highway	529
Herbicide	Amitrol-T	Vegetative control along highway	20
Herbicide	Picloram	Vegetative control along highway	3/4
Herbicide	MCPA amine	Vegetative control along highway	18
Herbicide	Methol benzoate	Vegetative control along highway	1
Herbicide	Diethanolamine salt of mefluidide	Vegetative control along highway	16

Table 9 Continued:

Pesticide (type)	Common Name	Purpose	Pounds Used
Herbicide	Asulam	Vegetative control along highway	23
Herbicide	Orzalin	Vegetative control along highway	15
Herbicide	2, 4D	Vegetation control along highway	113
Herbicide	2, 4D	Vegetation control on power line rights-of-way	812
Herbicide	Picloram	Vegetation Control on power line rights-of-way	216
Herbicide	Tridopyr	Vegetation control on power line rights-of-way	594
Herbicide	Tordon	Site prep. vegetation control of hardwoods	4,786
Herbicide	2, 4D	Release, hardwoods	4,972
Herbicide	Atrazine	Weeds and grass	12

Source: From USFS, pesticide use report for National Forest systems lands, FY-82.

The Kentucky Division of Forestry reports that less than 5,000 acres of state forest land are treated annually. The most commonly used pesticides on state forest land for general forestry uses and timber management practices are 2,4-D, simazine, roundup, and paraquat (KNREPC-DW, 1983).

PESTICIDES EFFECTS ON WATER QUALITY

Modern agriculture is an industry that uses scientific and technological development to meet the increasing demand for food and fiber production. In the decade of the seventies, Kentucky farmers doubled their row crop production (KNREPC) and in the same time more than doubled their use of pesticides (Table 1). According to the National Pesticide Information Retrieval System, there are currently 48,000 pesticide products comprised of 1,625 active ingredients registered for use in the United State. These chemicals have contributed greatly to bringing about increased crop yields and lowering production cost. However, these same pesticides that have been so beneficial to man and his environment are now recognized as a source of potential adverse environmental impact. The question of the environmental impacts of pesticide use is a very important one and, because of limited research, a difficult one to answer.

Pesticides belong to various and diverse chemical groups and according to R.D. Wauchope, research chemist, Southern Weed Science Laboratory S.E.A., USDA, Stoneville, Mississippi, "the only property that these chemicals have in common is their broad function as tools for crop protection. Once they leave the spray nozzle, they show vastly different persistence, mobilities, and toxicities... The dynamics of dillution and sediment exchange, uptake, transfer, and metabolism by aquatic life, of most of the pesticides presently in use, are not known. Without this knowledge, the impact of a given pesticide input on the quality of water in our streams and lakes cannot be predicted. However, what is known are the differences in persistence between organo-chlorine pesticides, most of which have been banned, and the later generation of pesticides now in use.

Herbicides are relatively non-persistent pesticides and it is generally agreed there is little evidence they are reaching or accumulating in our water supplies. (Herbicides represented 81.2 percent of Kentucky's state total pesticide use in 1979, Table 2). To my knowledge, there is no evidence that non-persistent pesticides have any permanent impact on aquatic ecosystems (see also Caro, 1977). This is not to suggest that such effects cannot exist, or that non-persistent pesticides might not be dangerous for other reasons-mammalian toxicity, carcinogenity, harm to nontarget species, atmospheric effect, etc. (See the following section on Aquatic Impacts of Pesticides in Kentucky).

The major controversy over pesticide use is a result of the harmful effects exhibited by the extremely persistent organochlorine insecticides...In summary, what we have at present is a fair ability to estimate edge-of-field inputs to water systems, combined with near complete ignorance as to what those inputs mean."

In 1983, Michael N. Beaulac of the Kentucky Natural Resources and Environmental Protection Cabinet, Division of Water developed a report entitled "The Use and Impacts of Pesticides in Kentucky."

He stated that "Pesticides are often categorized according to their use or intended target. These categories include the insecticides, herbicides, fungicides, nematicides, and fumigants which act as growth regulators, defoliants, and desicants. The term pesticide also applies to those compounds utilized as repellents, attractants, and sterilants. Those most widely used

in the greatest volume for producing our food and fiber crops are the herbicides, insecticides and fungicides, in their respective order of importance (Ware, 1975.) The pesticides of greatest concern are those that are, (1) persistent for long periods and accumulate in the environment, (2) highly toxic to humans, fish, and wildlife, and (3) used in large volumes over broad areas. The majority of these compounds (recommended for monitoring) are either insecticides or herbicides used extensively in agriculture, public health, and for household or garden purposes."

The following excerpts from Mr. Beaulac's report provides information on some of the chemical and toxicological characteristics of the major chemical groups.

<u>Organochlorines</u>

"Organochlorines (aka chlorinated hydrocarbons) are one of the most important groups of synthetic organic insecticides because of their number, wide use, intense toxicity to a wide range of target and non-target organisms, and relative chemical stability (persistence) in the environment. ...It was because of this persistence that the use of cyclodienes and diphenyl aliphatics for crops have been restricted; undesirable residues remained beyond the time of harvest. Many non-crop related organochlorines are even more persistent. Structures treated with chlordane, aldrin, and dieldrin for termite control are reportedly still protected from damage over 30 years after application (Ware, 1975).

Aquatic organisms, unfortunately, are more susceptible than terrestrial organisms to the toxicological effects of organochlorines. This is because (1) fish, invertebrates, and waterfowl are totally or partially immersed in their environment, and (2) lakes and streams act as pesticide sinks thus allowing for potentially high concentrations to accumulate. Because of these factors, and since organochlorines are so persistent, they tend to accumulate more in aquatic ecosystems than in terrestrial ecosystems.

The impact of organochlorines on aquatic organisms are highly variable and generally unpredictable.

Organophosphate and Carbamate Insecticides

"The organophosphates....are generally considered the most acutely (short-term) toxic of all pesticides to vertebrate animals. Unlike the chlorinated hydrocarbons, however, the organophosphates and carbamates are relatively unstable and are therefore comparatively non-persistent in aquatic and terrestrial environments and in animal and plant tissues. It is primarily for this reason that the latter insecticides have been increasingly used recently as substitutes for organochlorines to control agricultural and household pests.

While potentially highly toxic in the short-term, ... their general instability (short half-life) reduces the chances of these compounds from spreading widely throughout environments, or accumulating in environments and tissues (Whittaker, 1976).

Chlorophenoxy Herbicides

"The chlorophenoxy herbicides are applied to both terrestrial and aquatic substrates to control woody plants, herbaceous weeds, and aquatic vascular plants. There are several compounds belonging to this group, of which 2,4-D (until EPA's partial ban in 1979) and 2,4,5-T are the most widely used.

Chlorophenoxy herbicides degrade in the environment primarily through a microbiological breakdown process. Final breakdown products usually consist of CO_2 and water. As a whole, these compounds exhibit relatively short, but variable, half-lives in the environment. For example, 2,4-D is reported to persist in the soil for one to four weeks. In contrast, 65-75 percent of chloroxuron is still present 4 to 18 weeks after application (Weed Science Society of America, 1979).

This herbicide group (with some notable exceptions) exhibits little hazard of accumulation in the environment. Consequently, the relative order of biological magnification is low. It must be stressed, however, that in the short term, some of these herbicides such as 2, 4-D have the ability to produce carcinogenic, teratogenic, and mutagenic effects on humans (Elwood and

Rogers, 1975). This is especially true with dioxin - a contaminant inadvertently formed during the production of 2,4,5-TCP which is a major chemical feedstock for numerous herbicides including, 2, 4, 5-T, 2,4-D, clophen, and silvex (Buser and Bosshardt, 1974; Courtney et al., 1970; Edmunds et al., 1973; Zitko and Choi, 1971). Direct contact with this group of herbicides (or by-products) either during application or with the residues must therefore be avoided.

Triazine Herbicides

"Similar to the chlorophenoxy group, triazine herbicides are applied to both terrestrial and aquatic substrates for weed control. These compounds include simazine, atrizine, cyanizine, dipropetryn, metribuzin, prometon, and secbumeton. Ware (1975) reports that "the triamines are strong inhibitors of photosynthesis, and their selectivity depends on the ability of tolerant plants to degrade or metabolize the parent compound whereas the susceptible plants do not."

Chemical persistence of this group is generally greater and more variable than the chlorophenoxy herbicides. For example, the half-life of cyanazine on soils is approximately two weeks while prometon can persist for several years after application. Simazine, a water-soluble herbicide used for algae control in lakes and ponds, has a half-life in water of about thirty days (Weed Science Society of America, 1979).

Since some of the triazines are relatively persistent, the potential for accumulation (and biological magnification) in the environment and in organic tissues is increased. Toxicity of these herbicides, however, is relatively low compared to the chlorophenoxy group and especially in comparison to the organochlorine insecticides."

Aquatic Impacts of Pesticides in Kentucky

The Kentucky Natural Resource and Environmental Protection Cabinet, Divison of Water, in their report examined various sources of data and compiled tables on pesticide fish kills, fish tissue analysis, and reported pesticide spills and complaints. Those tables are reprinted herein along with pertinent excerpts from that report. The Kentucky Department of Fish and Wildlife Resources (KFDFWR) are responsible for investigating fish kills in Kentucky waters. The kills are investigated by conservation officers, district biologist and the Division of Water. The fish kills are reported annually in performance reports. Those incidents involving suspected pesticide kills are presented in Table 10 and are located on Figure 2.

TABLE 10: Pesticide Caused Fish Kills, January 1975-March 1982 (KDFWR Annual Reports)

Date	County	Stream/Lake	Miles/Acres Affected	Suspected Contaminant	Number Fish Killed	Assessed Value
5/11/76	Crittenden	Crooked Creek	-	Pesticides	-	-
5/13/77	Hardin	Buffalo Creek and Watershed Lake	0.5 miles	Chlordane, Methoxychlor	735	-
5/17/77	Hardin	Unnamed tributary to Buffalo Creek	-	Pesticides	-	-
9/02/77	Jefferson	Main Fork Beargrass Creek	0.5 miles	Pesticides	300	-
4/26/78	Bourbon	Green Creek	3.0 miles	Insecticide	-	-
5/02/78	Fayette	Farm pond	2.5 acres	Herbicide (Copper Sulfate	500	-
7/14/78	Fleming	Fox Creek	2.0 miles	Pesticide	1,246	-
5/30/79	Jefferson	South Fork Beargrass Creek	1.1 miles	Chlordane	30,119	$2,025.27
5/30/79	Allen	Buck Creek	-	Herbicide	-	-
8/27/79	Jessamine	Wymers Creek	1.0 miles	Chlordane, Heptachlor	1,990	$ 524.51
8/24/81	Harlan	Martins Fork	0.1 miles	Herbicide	75	-
8/31/81	Campbell	Phillips Creek	0.5 miles	Herbicide	30	-

Source: From the KNREPC-DW, 1983, Report

Pesticide Impact Locations

● Pesticide-causing fish kills
■ BMWP Stations
▲ Pesticide spills and complaints

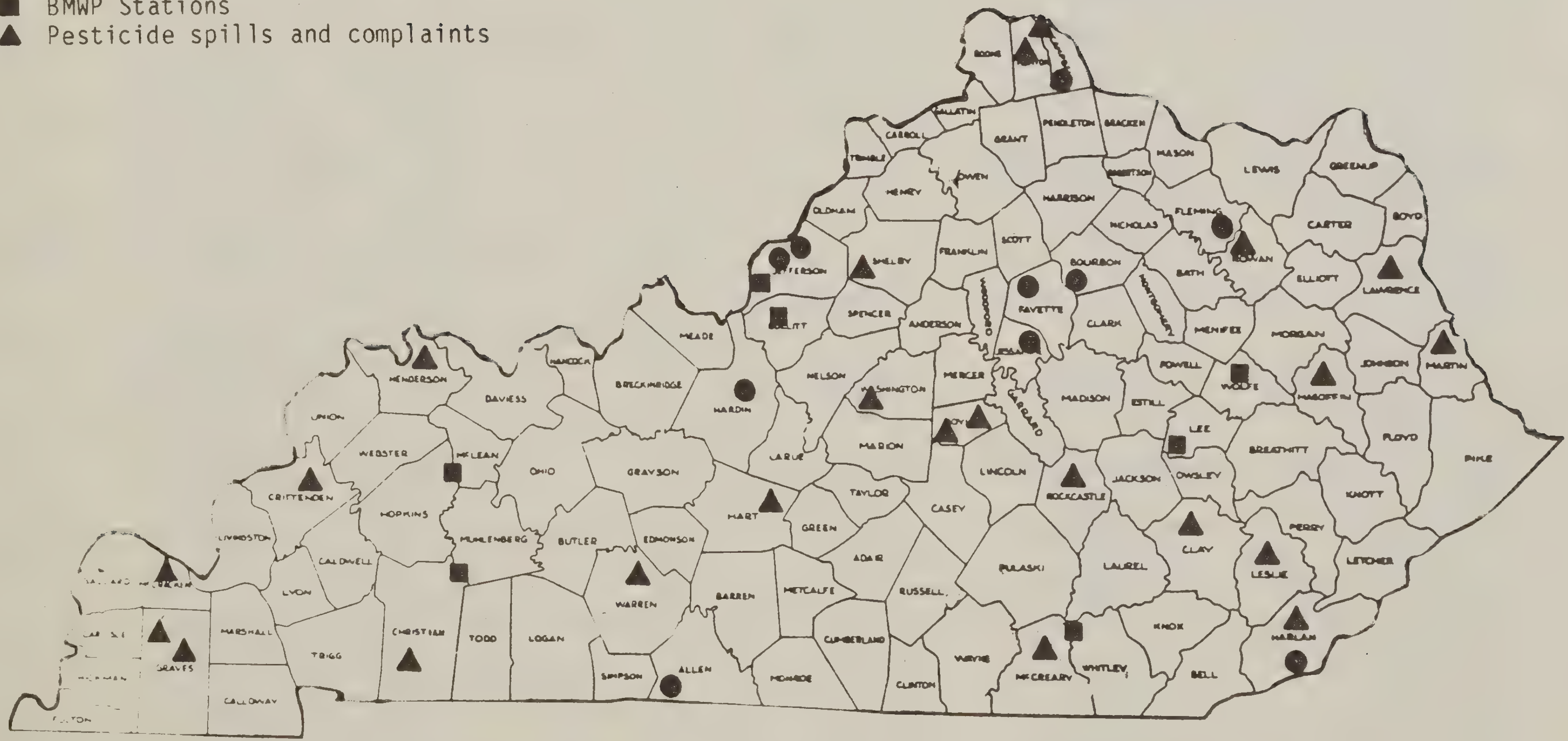


FIGURE 2

Source: From KNREPC-DW, 1983 Report

Fish Tissue Analysis

Fish tissue analysis is one method used by the Division of Water to monitor the effects of pesticides in the aquatic environment. Fish captured at Environmental Protection Agency's basic water monitoring stations are analyzed for concentrations of aldrin, dieldrin, DDT, chlordane, endrin, methoxychlor, hexachlorobenzene, pentachlorophenol, hexachlorogylohexane, and toxaphene. The results of the analyses are shown in Table 11.

"Of all the reported pesticides, chlordane alone either surpasses or approaches the U.S. F.D.A. action level 1 of 0.30 $\frac{mg}{kg}$ (U.S. FDA, 1980)" (KNREPC-DW).

It is also noted in KNRECP's report that chlordane is the most frequently occurring pesticide.

TABLE 11: Fish Tissue Analysis Pesticide Concentrations (BWMP Stations, 1979-1981)

Date	Station #	County	Tributary	Nearest Community or Landmark	Sample Type	Contamination	Concentration Level
11/14/79	12032900	Jefferson	Pond Creek	Louisville	sauger	aldrin	0.162 mg/kg
						pentachlorophenol	0.179 ug/g
					channel catfish	chlordane	0.270 mg/kg
10/8/80					carp	chlordane	1.42 mg/kg1/
						methoxychlor	0.11 ug/g
						hexachlorocyclo-hexane (Gamma BHC)	0.012 mg/kg
					largemouth bass	chlordane	1.98 mg/kg1/
8/6/81					redhorse sucker	dieldrin	0.043 ug/g
					catfish	dieldrin	0.034 ug/g
						pentachlorophenol	0.039 ug/g
7/16/80	03004900	McLean/ Hopkins	Pond River	Below Isaac Creek	carp	chlordane	0.70 mg/kg
						hexachlorobenzene	0.017 mg/kg
						pentachlorophenol	0.026 ug/g

TABLE 11: Continued

Date	Station #	County	Tributary	Nearest Community or Landmark	Sample Type	Contamination	Concentration Level
7/16/80 (continued from previous page)						hexachlorocyclo-hexane (alpha BHC)	0.032 ug/g
					bluegill	dieldrin	0.067 ug/g
						chlordane	0.05 mg/kg
						methoxychlor	0.38 ug/g
8/20/81					crappie	aldrin	0.020 mg/kg
						dieldrin	0.030 ug/g
						chlordane	0.262 mg/kg
						hexachlorobenzene	0.024 mg/kg
						pentachlorophenol	0.008 ug/g
11/20/79	04039900	Lee	Kentucky River	Heidelberg L&D #14	spotted suckers	chlordane	0.20 mg/kg
						methoxychlor	0.20 ug/g
					bluegill	aldrin	0.027 mg/kg
						methoxychlor	0.20 ug/g
						pentachlorophenol	0.05 ug/g

TABLE 11: Continued

Date	Station #	County	Tributary	Nearest Community or Landmark	Sample Type	Contamination	Concentration Level
9/10/80	(continued from previous page)				redhorse suckers	chlordane	0.28 mg/kg
						hexachlorocyclohexane (alpha BHC)	0.037 ug/g
					bluegill	hexachlorocyclohexane (alpha BHC)	0.023 ug/g
						hexachlorocyclohexane (Gamma BHC)	0.011 mg/kg
7/29/81					bluegill	hexachlorocyclohexane (alpha BHC)	0.0007 ug/g
6/19/80	02018900	Whitley/ McCreary	Cumberland River	Above Cumberland Falls	redhorse sucker	chlordane	0.29 mg/kg
						endrin	0.020 mg/kg
						hexachlorocyclohexane (alpha BHC)	0.024 ug/g
					channel catfish	pentachlorophenol	0.034 ug/g
8/18/81					redhorse sucker	dieldrin	0.028 ug/g
					flathead catfish	dieldrin	0.02 ug/g
						pentachlorophenol	0.009 ug/g

TABLE 11: Continued

Date	Station #	County	Tributary	Nearest Community or Landmark	Sample Type	Contamination	Concentration Level
10/17/79	04043900	Wolfe	Red River	Hazel Green	longear sunfish	pentachlorophenol	0.05 ug/g
					redhorse sucker	hexachlorobenzene	0.025 mg/kg
						pentachlorophenol	0.05 ug/g
10/16/80					rock bass	hexachlorobenzene	0.017 mg/kg
						dieldrin	0.04 ug/g
					redhorse sucker	hexachlorocyclohexane (alpha BHC)	0.024 ug/g
8/4/81						ND	
12/6/79	03004901	Muhlenberg/ Christian	Pond River	Apex	crappie	methoxychlor	0.069 ug/g
						hexachlorocyclohexane (alpha BHC)	0.006 ug/g
						pentachlorophenol	0.020 ug/g
					channel catfish	pentachlorophenol	0.096 ug/g

TABLE 11: Continued

Date	Station #	County	Tributary	Nearest Community or Landmark	Sample Type	Contamination	Concentration Level
7/16/80 (Continued from previous page)					carp	chlordane	0.63 mg/kg
						pentachlorophenol	0.029 ug/g
8/20/81					crappie	aldrin	0.020 mg/kg
						dieldrin	0.030 ug/g
						chlordane	0.262 mg/kg
						hexachlorobenzene	0.024 mg/kg
						pentachlorophenol	0.008 ug/g
10/26/79	12002900	Bullitt	Salt River	Shepherdsville	white crappie	chlordane	0.20 mg/kg
					sauger	chlordane	0.20 mg/kg
						pentachlorophenol	0.065 ug/g
10/10/80					redhorse sucker	chlordane	0.42 mg/kg
						pentachlorophenol	0.025 ug/g
					bluegill	pentachlorophenol	0.027 ug/g
8/12/81					redhorse sucker	pentachlorophenol	0.033 ug/g

1/ Concentration Exceeds FDA Limits Table 11: Taken from KNREPC-DW 1983 report.

Source: Taken from KNREPC-DW, 1983 report

Pesticide Spills and Complaints

Private citizens of the commonwealth are concerned with the quality of water and this concern is borne out by their frequent calls to report pesticide abuse.

Numerous complaints involving water pollution have been reported by the general public to Division of Water field offices and to the enforcement branch at Frankfort. These reports include incidents of spills to drinking water taste and odor complaints. Depending on the nature of the report, the site is investigated by a field inspector and water samples are collected for later analysis (KNREPC-DW, 1983).

Table 12 from the KNREPC report shows a compilation of the investigations where pesticides are the suspected contaminant.

TABLE 12: Reported Pesticide Spills and Complaints (DOW Spill and Complaint Files, 1980-1982)

Date	County	Nearest Community	Water Body Impacted	Suspected Contamination
8/30/80	Graves	Mayfield	Mayfield Creek	pesticide
12/12/80	Campbell	East Newport	Taylor Creek	pesticide
1/29/81	Shelby	Finschville	Private pond and well	Round-up, Atrazine Paraquat
4/20/81	Graves		Private pond	2,4-D
4/20/81	Warren	Plum Springs	Farm pond	thistle control
4/23/81	McCracken	Paducah	Well	Chlordane
6/11/81	Boyle		Private pond	paraquat, Aatre bush killer (Formula 40)
6/22/81	Kenton	Independence	Banklick Creek	herbicide
8/6/81	Boyle	Danville	Clark's Run	Atrazine
8/18/81	Rockcastle		Roundstone Creek	bacteriocide or pesticide
8/30/81	Graves	Mayfield	Mayfield Creek	pesticide

TABLE 12: Continued

Date	County	Nearest Community	Water Body Impacted	Suspected Contamination
7/16/82	Hart	Canmer	Green River Valley Water Supply	Orthene
8/2/82	Rowan		North Fork Triplett Creek	insecticide
8/13/82	Washington	St. Catherine	St. Catherine Junior College Water Supply	herbicide
9/8/82	Christian		Little River	herbicide

Source: Taken from KNREPC-DW, 1983 Report.

FIELD LOSSES OF AGRICULTURAL PESTICIDES

Factors Affecting Washoff of Agriculture Pesticides

Pesticides are transported from the site of application by several mediums including water, soil, and air.

A major pathway for pesticide removal from a treated agricultural field is in runoff water and on sediment carried along in the water. The amount of field-applied pesticide that leaves a field in this manner and enters a stream depends primarily upon the intensity and duration of the rainfall, and the length of time between pesticide application and rainfall occurrence (J. M. Davidson).

Generally, the largest pesticide loss occurs when rainfall is intense and occurs shortly after pesticide application, a condition for which water runoff and erosion losses are greatest (J. M. Davidson).

Other factors affecting pesticide losses are:

a. Site conditions

   Site size, type soils, type vegetation, topography (slope) erosiveness of soil, tillage operations, etc.

b. Properties of the pesticide

   Persistence in the soil, which is related to volatility, photodecomposition, adsorption, leaching, plant uptake, microbial decomposition, water solubility, and chemical decomposition.

c. Method of pesticide application.

   Surface applied, incorporated, foliar.

Predicting Edge of Field Losses of Pesticides

Washoff of agricultural pesticides have been studied intensely in the past decade and there are numerous experiments and reports on pesticide loss in runoff water from croplands. R.D. Wauchope reviewed the literature through the spring of 1977 on this subject. An abstract of his work was published in "The Journal of Environmental Quality, Volume 7 No. 4" in 1978. The goals of the review were (1) to tabulate "edge-of-field" concentrations and loads of pesticides for which data was available, (2) to suggest rules of thumb for estimating losses which may be used for water quality planning in large regions or basins, and (3) to suggest research areas that need more attention.

The following excerpts are directly from Mr. Wauchopes paper including his suggestions (underlined) for predicting edge-of-field losses of pesticides.

"I would like to propose three classes of pesticides by potential annual loss or environmental impact that might be useful in water-quality planning for large regions or basins.

Foliar Applied Organochlorine Insecticides

"These are lost in relatively large amounts because they are persistent and because, compared with other pesticides, large quantities are applied. In addition, they are toxic enough to aquatic life so that runoff can produce acute effects such as fish kills. I suggest an average of one percent-per year of the amounts applied be used as an estimate of runoff losses.

Wettable Powder Formulations

"The consistently high losses reported for triazine and other wettable powder-formulated herbicides, even though these materials are not particularly persistent, place them in a class by themselves. I suggest loss estimates of 2 percent for slopes of 10 percent or less-and 5 percent for slopes over 10 percent.

Nonorganochlorine Insecticides, Incorporated Pesticides, and all Other Herbicides

"These make up the remainder of the pesticides that have been studied. Losses are quite varied, but considering that rather severe runoff situations have been the rule in these studies. I suggest a 0.5 percent-loss estimate for these pesticides.

Conservation Practice Affects on Pesticide Loss

"If a pesticide is carried off a field primarily in the sediment phase of runoff, then its loss should be controllable by soil conservation practices... It could be hoped then, that eventual better control of erosional losses of soil would also reduce "piggyback" pesticide losses. Unfortunately, although pesticide concentrations are often 2-3 orders of magnitude higher in sediments than in associated water..., most pesticides are still lost mainly in the water phase, simply because sediment is usually such a small fraction, by weight, or by volume, of runoff." (R. D. Wauchope)

"Water is the major pathway through which pesticides get into the environment" (Water Quality Bulletin, EPA 1983).

"Erosion control practices that reduce runoff and soil movement will have a positive effect in reducing pesticide loss. However, "erosion control practices, except as they control water as well as sediment losses, can be expected to have little effect on runoff losses of pesticides... Several experiments, in which low-till or other erosion control practices have been studied, bear this out. Baker et al. (1976) used six different cultural practices in small simulation studies; erosion was decreased in some cases but runoff losses of alachlor and cyanazine were little affected. Losses of fonofos, a more insoluable compound, were decreased by erosion control. Smith[5] found that losses of atrazine and dephenamid were similar on terraced and non-terraced watersheds, but terraced watersheds gave much lower sediment and paraquat losses" (R. D. Wauchope).

CONCLUSIONS

Agriculture is by far the major user of pesticides in Kentucky with 22,109,170 pounds of active ingredients used in 1979. The use of chemical pesticides in the United States has increased approximately 15 percent annually over the last decade, and the same percentages are likely to continue over the next few years. During the period from 1974 to 1978 the increase in pesticide use in Kentucky far exceeded the national trend.

Pesticides belong to various and diverse chemical groups, and they show vastly different persistence, mobilities, and toxicities. Presently, very little is known of the dynamics of dillution and sediment exchange, uptake, transfer, and metabolism by aquatic life of most pesticides. For this reason the impacts of a given pesticide on the quality of water in our streams and lakes cannot be predicted.

However, what is known, are the differences in persistence between the organo-chlorine pesticides and the later generation of pesticides now in use. It is thought by some investigators that the major controversy over pesticide use is the result of the harmful effects caused by the extremly persistent organochlorine insecticides, most of which have been banned or restricted. It is generally agreed that there is little evidence that the relatively non-persistent herbicides are reaching or accumulating in our water supplies. Despite the fears and problems created by the use of chemicals for pest control, it is generally believed by scientists that the benefits derived from the use of today's pesticides outweigh the risks to the environment.

There have been many investigations of pesticide losses in runoff from crop land. They lead to a general conclusion, that the total amount of pesticides washing off the land during croping season is less than 5 percent. There may be one exception and that is when heavy rainfall occurs shortly after application.

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